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TESTIMONY
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QUALCOMM, INCORPORATED.
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON AVIATION
HEARING ON CELL PHONES ON AIRCRAFT: NUISANCE OR NECESSITY?
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QUALCOMM is a leading developer and supplier of digital wireless communications products and services. QUALCOMM has developed core wireless technology based upon code division multiple access (CDMA). CDMA is the world standard for the wireless communications industry. The company's roots are in the transportation industry; QUALCOMM's earliest success is OmniTRACs, a two-way, end-to-end satellite communications fleet management system that transformed the long-haul trucking industry by increasing productivity and enabling just-in-time delivery. In 1995, QUALCOMM was the first recipient of the Department of Transportation's "Secretarial Award for Excellence in Transportation Technology Research and Development" in recognition of the OmniTRACS system's contribution to improved efficiency, safety and environmental quality.

This testimony addresses the extensive research and development that QUALCOMM has conducted in the area of wireless communications technology for aviation use. Our primary goal has been to determine whether cell phone use can be implemented safely and reliably on aircraft within acceptable interference standards for both aircraft communications systems and ground-based wireless networks.

The results of our research, which has focused primarily on CDMA technology, have been very promising, although we believe further research needs to be undertaken. In addition, the testimony addresses the issues of in-flight cell phone etiquette and homeland security, two issues that have arisen as the technology to permit cell phone use on an aircraft has come closer to reality.

The Pico Cell System

QUALCOMM is an original member of RTCA Special Committee 202 (SC – 202) and I am co-chair of working group 4 of this committee. Our participation in SC-202 and interaction with other industry groups has led QUALCOMM to engage in

a program of development, analysis, and testing to assess the potential for mobile phone interference with aircraft systems and terrestrial mobile phone networks.

The system that we have used as the platform for our research and analysis allows wireless devices on an aircraft to communicate to and from a pico cell, which is mounted in the aircraft. The pico cell is connected to the ground through a licensed air-to-ground link. A pico cell uses standard cellular base station transceiver technology that has been packaged into a unit the size of a laptop. This unit has very low transmitter power as it is designed to provide cellular coverage to small areas with a relatively high number of users. In addition, the system consists of a base station controller, and antenna subsystem. Because wireless devices on aircraft are in close proximity to the pico cell, they transmit at significantly lower power levels compared to when they are used on the ground. Typically they do not get as close to the standard cellular base stations used in the ground networks.

A CDMA on board pico cell can support up to 100 simultaneous users and enables both voice and data communications, i.e. text messaging, internet access, e-mail, and other non-voice services such has multimedia down loads. The air-to-ground link bandwidth limits the number of simultaneous calls or data rate per passenger. With the exception of Connexion By Boeing's system, the air to ground links used in most commercial aircraft today are only capable of 10's of kbps, which can only support a small number of voice calls or low data rate for passengers using data services. QUALCOMM understands that is about to change with the introduction of new broadband links proposed by companies such as Verizon Airfone.

QUALCOMM/American Airlines Demonstration

On July 15, 2004, QUALCOMM and American Airlines conducted a successful, live, proof-of-concept demonstration of the CDMA pico cell technology. The demonstration allowed passengers to use mobile phones on a commercial aircraft (MD Super 80), including both two-way voice communications, and short text messaging service. Up to 15 simultaneous calls were supported by the system.

For the live demonstration, QUALCOMM obtained an experimental license from the FCC. The Qualcomm equipment installation in the aircraft was certified via a Supplemental Type Certificate. American Airlines worked with its FAA representatives to get their concurrence on the unique aspects of the charter flight. Prior to the demonstration, QUALCOMM and American Airlines conducted a number of ground based and airborne tests to identify any interference with the actual aircraft and to identify and solve some of the design challenges associated with an airborne system. No aircraft interference was detected.

The ground segment of the airborne system was connected into the public network as well as the Sprint PCS wireless network. As a result, passengers were able to use their own Sprint CDMA phones. For purposes of this demo, the air-to-ground link was provided through the Globalstar satellite system and its commercial gateway in Clifton, Texas.

Other QUALCOMM Research To Date

In addition to the testing performed in collaboration with American Airlines, QUALCOMM has conducted three other significant test programs using the CDMA pico cell system and multiple CDMA phones. First, in June 2003 QUALCOMM made measurements on a Boeing 727 aircraft in order to determine aircraft cabin propagation characteristics including signal addition and cancellation as a result of the metal fuselage. Another goal of this test program was to determine how much shielding is provided by the aircraft skin at cellular and PCS frequencies.

Second, from 2003 to 2004 QUALCOMM used a corporate business jet aircraft to measure cell phone activity over the course of ten flight legs across the continental U.S. and up and down the West Coast. QUALCOMM collected logs from PCS and Cellular phones on board the aircraft at all phases of the flight. The data allowed us to understand the behavior of commercial CDMA handsets during in-flight conditions and establish the power levels necessary for an airborne CDMA pico cell system to overcome the signals radiating from the ground networks.

Third, in conjunction with Boeing in April 2004, QUALCOMM conducted research into the potential interference from a CDMA pico cell system to terrestrial wireless networks. During this exercise, 100 commercially available handsets were distributed evenly throughout the passenger cabin and flight deck of a single aisle MD-90 aircraft. Measurements were taken exterior to the aircraft out to a range of approximately 1 km under two test case scenarios: one using the in-cabin pico cell and the other "worst case" scenario where all phones were manually set to full power transmission uncontrolled by the onboard pico cell. As the QUALCOMM engineering team measured the CDMA signals radiating from the aircraft, a team of Boeing engineers and an FAA observer were making measurements on the aircraft systems to determine if there was any interference. No anomalies were observed. A full report was submitted to the RTCA SC-202 for review by the committee.

More information about the research we have conducted on this topic is available in our filing of May 26th, 2005 at the FCC in its proceeding on the use of cellular telephones and other wireless devices aboard airborne aircraft.

Results of Research to Date

The test results to date are promising. One key feature of CDMA technology is the range of the closed loop power control. When CDMA phones are close to the cell tower they transmit at micro-watt power levels. In the case of the airborne pico cell QUALCOMM has verified that in the aircraft cabin environment cellular and PCS CDMA phones can be power controlled such that they are transmitting micro-watts at all locations within the cabin. This very low level of power significantly reduces the potential for interference to aircraft systems and terrestrial networks. When compared to Wi-Fi devices that have been approved for use on certain commercial aircraft today, the pico cell controlled CDMA phone is transmitting at approximately 1,000 times lower power.

In addition, our research has indicated that the combined transmit power of all phones that connect to and are controlled by the pico cell is significantly lower than the power of any single phone that has been left on and attempts connection with ground networks while airborne. Reports have shown that in spite of the existing restrictions on the use of cell phones on aircraft, nearly every commercial flight has at least one transmitting cell phone. In addition, some passengers are intentionally using their cell phones/PDAs for communications with ground networks while in flight. Although this connectivity is not reliable at cruising altitudes, it is possible to achieve reasonable connectivity at lower altitudes such as in the climb and descent phases of flight.

In support of RTCA SC-202 QUALCOMM has presented a number of reports detailing emissions from mobile phones, their failure modes and transmit characteristics. We supported NASA Langley[1] in a test program that they performed on 3G mobile phones and they reported that in most cases, phones have better safety margins than laptops and PDAs due to their lower emissions. Laptops and PDA's are approved for use today on all commercial aircraft and in the case of Lufthansa the Wi-Fi feature on these devices is also approved for use.

Regarding terrestrial networks, the tests indicate that airborne CDMA networks present the lowest levels of interference due to the range of power control. Other technologies do not power control down to the levels of CDMA and so present a higher potential for interference. Further work is required to determine what level of interference would be found tolerable by the terrestrial carriers and what are the necessary countermeasures to meet these requirements.

QUALCOMM believes that it should be up to the wireless carriers to decide whether they want to accept a low level of interference in exchange for the revenue-generating opportunities the wireless carriers will enjoy from the use of

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[1] **Third Generation Wireless Phone Threat Assessment for Aircraft Communication and Navigation Radios** , NASA/TP-2005-213537, March 2005

these devices on planes. No wireless carrier should have to accept interference involuntarily.

In sum, we believe that an onboard pico cell does have the potential to allow the safe introduction of cell phone service on aircraft. With the continued growing penetration of cell phone use in this country, it is important that the Government update its regulations to address current technical and market conditions. We applaud the FAA and the FCC for undertaking reviews of their regulations in this area.

Additional Research Areas

QUALCOMM is currently engaged in the following research areas:

First, we will continue to support RTCA SC-202's work to evaluate compatibility between transmitting passenger electronic devices and aircraft avionics. This includes participation in collaborative testing with consumer equipment manufacturers, aircraft manufacturers, avionics equipment manufacturers, airlines, and research groups from government and academia.

Second, we are evaluating what mechanisms can be introduced to prevent an airborne phone from attempting to connect with the ground networks in preference to an on-board pico cell. RF-based solutions such as aircraft shielding and noise floor elevation will be tested in conjunction with industry partners to evaluate their relative efficacy, practicality, cost-effectiveness, and cross-technology compatibility.

Third, so far, evaluation of potential interference to terrestrial mobile networks has been based on link budget analysis incorporating assumptions about aircraft penetration losses and other variables. Attempts to measure air-to-ground interference experimentally have been inconclusive to date. We will perform further ground-based aircraft testing in conjunction with industry partners to evaluate the characteristics of signal leakage from aircraft cabins. We also plan to do flight tests to measure aircraft-to-ground and ground-to-aircraft propagation under well-controlled conditions to validate our analyses and ground-based measurements. Aircraft position and orientation with respect to the ground measurement site must be carefully accounted for during all tests.

Fourth, there is general agreement in the industry that any in-flight system implemented for use in the U.S. must support both cdma2000 1X and GSM at a minimum. It is likely that other technologies such as 1xEV-DO, 802.11a/b/g and WCDMA will be supported at some point. These multi-technology systems pose unique design challenges which require further research, development, and testing.

Public Interest Issues

QUALCOMM is aware that a number of public interest issues have been raised as the FAA and FCC continue their processes of evaluating the feasibility of introducing cellular use on aircraft. We would like to offer a few thoughts on these public interest issues that arise from our research and development in this area.

Etiquette. Some have claimed that cell phone use on aircraft will disturb passengers who are hoping for peace and quiet. From the technology perspective, the mobile phone is "tuned" to pick up voice frequencies and so there is no need for passengers to speak loudly. In fact, shouting into a CDMA phone causes distortion due to the sensitivity of the technology. This became very apparent to the passengers during the American Airlines demo and they quickly adapted and reduced their voice level significantly.

QUALCOMM recognizes that should voice services be chosen by an airline, some passenger education is required as people will naturally talk louder due to the high ambient noise level of the aircraft. We would anticipate that the airline would be responsible for this aspect of passenger etiquette, just as airlines today routinely enforce other aspects of passenger etiquette.

QUALCOMM would also like to highlight the fact that data services are a key component of wireless connectivity, and today's 3G cellular and PCS networks have evolved to support these key services. The same data services that are offered today by the terrestrial service providers would also be enabled through the use of CDMA pico cell technology on board aircraft. This would provide passengers with in flight access to e-mail, web searches, games and multimedia downloads. We believe the air carriers can devise appropriate parameters to cell phone use as part of their efforts to attract and maintain passengers.

Finally, even if cellular/PCS phone wireless connectivity is not provided on a commercial aircraft the passengers will want to use the non-wireless features of their phones such as games, music player, personal organizer, pre-loaded videos/media. In this case the airlines must have procedures in place to ensure the radio is disabled. This would also be desirable from the terrestrial provider's perspective as they do not want the increased interference due to cellular/PCS phones being active and potentially transmitting and attempting connection to ground systems.

The comments provided by QUALCOMM apply to Wireless Wide Area Network (W-WAN) devices using the cellular and PCS frequency bands. Such devices include much more than just mobile phones—devices such as Blackberries, WWAN-enabled laptops (i.e., laptops using PC cards to access wireless data service over the cellular and PCS bands), and PDAs.

Homeland Security. The FAA's and FCC's existing limitations on the use of cell phone use were not put in place to combat terrorism, but rather to prevent interference to terrestrial ground networks and avionics. If it is proven that the interference from new systems such as the pico cell do not pose an unacceptable risk of interference either to avionics or terrestrial wireless networks, the existing prohibitions will no longer serve a purpose. Whether additional restrictions are in order for other reasons, such as to preserve homeland security, is a question the appropriate agency or agencies within the Federal Government would need to review. However, with the introduction of broadband connectivity to commercial aircraft through systems such as Connexion by Boeing, passengers today have the ability to use PDAs, laptops and mobile phones with Wi-Fi capability to communicate with the ground using instant messaging, e-mail and even voice over IP. This is happening today on Lufthansa and is expanding to other airlines that fly over the United States.

Conclusion

QUALCOMM has done considerable research on the question of interference to avionics and terrestrial wireless networks from the use of portable electronic devices using a CDMA pico cell network. This system shows promising capabilities for allowing aviation passengers to use a wide range of mobile devices while in flight without compromising the safety of the aviation system or the reliability of terrestrial wireless networks. Some additional work needs to be completed, and we stand ready to assist Government agencies in completing the necessary research. Today's mobile phone has many capabilities beyond basic voice. Increasingly consumers are relying on their mobile devices for such applications as e-mail, multimedia downloads, entertainment, internet access and even live TV. These applications are available today on certain commercial airlines, and will become the expectation of flying consumers as the use of mobile electronic devices continues to grow. It is therefore imperative that Government regulations address the complex safety and public interest issues related to the use of portable electronic devices on aircraft.